Essay Review

Metaphors Chemists Live By

Theodore L. Brown, *Making Truth. Metaphors in Science*, University of Illinois Press, Champaign, IL, 2003, xi + 215 pp. [ISBN 0-252-02810-4]

by Pierre Laszlo

Editors of journals and magazines wish for book reviews to convey the contents of a book, its attractiveness and general merits. But they are smart enough to welcome good copy, if the reviewer has anything original to say. Which is not to condone the admittedly bad habit, on the part of some reviewers, to abuse their prerogative by outlining how they would have tackled the topic at hand, paying lip service only to what after all is their duty, *i.e.*, to report honestly on a read.

If I open in such a manner this review, obviously it is meant to signal that I intend to stray from the straight and narrow. But I have good cause for doing so, since my awareness of Professor Brown's biography brings an extra dimension to my appreciation of his fine, well thought-out book.

Theodore L. Brown has had three if not four careers: those of a scientist of the first-rank, who pioneered a distinctly original area in organometallic chemistry; of the author of a highly successful textbook, *Chemistry: The Central Science*; of a university administrator, who had the pleasant duty but nevertheless the responsibility of translating a $40-million gift into a lively research institute; and, last but not least, that of a would-be philosopher of science. Since I can almost hear the sneering from fellow-chemists, among whom a taste for either or both of history and philosophy is synonymous with senility, let me only say that such comments disgrace the people who utter them. They mix impotence and envy.

Hence, my first comment is addressed to the lovely title, *Making Truth*. Professor Brown knows what he is writing about, he did make a profession out of making science and, in the process, his job was as a spokesman for truth. The task of a scientist is this everlasting effort at telling the truth about the world – an everlasting attempt since it has constantly to be renewed,

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whatever the topic of inquiry. Making truth? The verb 'to make', in its multiple meanings, nevertheless has the connotation of action; moreover, of an actual action as performed by one's hands. I like that title; it emphasizes most cogently, most concisely as well, in a formula which Francis Bacon might have coined, what the intent and the method of experimental science are. Actually, Brown derives this fine title from a quotation by Richard Rorty (in *Contingency, Irony and Solidarity*, reproduced in the epigraph), to the effect of descriptions of the world being by necessity in the form of sentences, and thereby having no existence independently of the mind. From a realist viewpoint, the book unfolds. It has ten pithy chapters.

Chapter 1 is programmatic. Chapter 2 introduces briefly to metaphor, with examples from the language of the everyday. Chapter 3 involves a brief introduction to the theory of conceptual metaphor, as presented by George Lakoff and Mark Johnson in their book *Metaphors We Live By*. Chapters 4 and 5 recount the history of our conception of atoms, as seen through the prism of metaphors. Likewise, chapter 6 takes up the metaphors implicit in the building of molecular models. Chapter 7 is devoted to the metaphor of protein folding, and chapter 8 takes higher order biological systems, such as the functioning of a cell described by analogy with a factory. Chapter 9 addresses, again through the agency of metaphorical thought, the issue of global warming. And the last chapter is an overall recapitulation.

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If there is a flaw in this otherwise very good book, it has to do with its intended audience. Brown has written it, maybe without fully realizing it, for his fellow scientists. The argument is lost on them. In their overwhelming majority, they could not care less.

To them, the idea of a reflexive self-examination is an oddity. That the scientific profession shares the intellectual tool of the metaphor with the humanities, do they care about? They might find issue with it, they might find it a trifle deprecating. The competitive pressure they operate under is such as to preclude any kind of a thoughtful standing back on their part.

Professor Brown ought to have directed his book to the audience it truly deserves. He could have used the empirical evidence about the behavior of scientists, so familiar to him, in order to analyze the use of metaphors by scientists for the sake of philosophers of science and sociologists.

Let me give an example. I shall build from an allusion in this book to what might have been done and, in all likelihood, the author could have achieved. In his summary (chapter 10), while describing the superstructure of science (the granting agencies), Brown writes thus:

> […] fashionable science tends to be funded at the expense of other, possibly more creative, riskier ideas. What is fashionable in turn tends to be defined by

> a select handful of commanding metaphors. For example, today the metaphors of 'nanotechnology', 'self-assembly', and 'combinatorial methods', applied across the research areas of materials, drug discovery, and biological science, are commanding metaphors.

Are we to understand, then, that the tool for thought, the metaphor, just like the tongue to Æsop, can be more of a bad thing than of a good thing? What are these 'commanding metaphors'?

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A useful exercise would be – and Professor Brown was in a position to do so – to examine how a metaphor, that of self-assembly say, has risen to the top; and how it did achieve its eminence: historically, sociologically, psychologically, and administratively. Does the wording, 'self-assembly', give out such a euphonious echo as to have eased the ascension into such a lofty position? Was it a matter of a handful of prestigious and powerful scientists – and it would be good to be specific here and to name a few names – setting the trend deliberately? Did they do so lobbying for their self-interest only, or out of a sense of a mission, to lead the scientific community on a path which they were convinced was worth pursuing? How does this particular metaphor relate to the craft of woodwork, that of the cabinetmaker who puts together a carefully wrought piece of furniture? How does it relate to other crafts, such as clock building or assembling other mechanical devices? How does it relate to sociology and to behaviors which congregations or crowds of people are wont to display? How does it relate to particular biological processes, which came to be studied and unraveled during the last few decades, such as the mechanism of muscular action understood at a molecular level?

By raising and by answering such questions, one grasps a distinctive merit of the self-assembly metaphor. It has a unifying role. Its very fuzziness brings together under a single umbrella all these areas. Is it then a surprise if, within granting agencies, academic committees and administrative officers go for such a metaphor? They do so in the wish to ingratiate themselves with legislators and, ultimately, with the electorate and the taxpayers.

But the self-assembly metaphor has yet another merit. It draws upon a powerful factor that, in itself, explains its success. It connects with the notion of robots. More precisely, it amounts to a fusion between the concept of a robot and the software which the robot is programmed to follow. The self-assembly metaphor harbors the notion of a molecule that, once it has been designed for a given function, will carry it out on its own. The design becomes consubstantial with the action, in a zenith of teleology.

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What is it in such a notion as 'self-assembly' that touches such a deep chord? Why is it that the carrying-out of a blueprint by a molecule embodying its specifications holds such fascination?

The answer has to do with miniaturization, as a driving force of technology and thus of the economy ever since the invention of the transistor. Indeed, it is no accident if Brown mentions in the same breath, in the same sentence, nanotechnologies and self-assembly. They partake in the same research program, where one of the admittedly distant goals is the manufacturing of molecular computers whose performances would ridicule those of the present-day computers born *ab silico*.

But part of the answer has also to do with rhetorical amplification, as chemists improve in their ability to utter hype in order to advertise and sell their wares. This much is apparent from an outline of the genealogy of self-assembly as a concept. It derives from molecular recognition, which in turn derives from complementarity. We owe the introduction of the latter concept to Linus Pauling, who saw it as one of the keys to the molecular biology he and others were building. For Linus Pauling, complementarity was central to an area in which, in spite of his desire, he made no lasting contribution, that of immunology.

Let me remind the reader, at this point, of a description which Pauling came up with. He was discussing in the mid-1940s the role of molecular complementarity in biology for the members of the American Chemical Society ('Molecular Architecture and Biological Reactions', *Chemical and Engineering News*, **24** [1946], 375). He used as an example the sugar crystals one finds occasionally in a pot of jam. The merit of the example is, first, the improbability of such a seemingly mundane occurrence, if one thinks of it: that crystals of a pure substance should arise in the midst of an extremely complex mixture, associating dozens of diverse chemicals, partakes of a small miracle. Which Pauling explains: any molecule of sucrose, wandering about in the solution, pushed hither and thither by Brownian motion, has its niche, its resting place so to say, already prepared for it within the crystal. The growing crystal holds a hole whose shape is complementary to that of the errant sucrose molecule. It is only a matter of trial and error, of collisions repeated billions of times, before the sucrose molecule finds its allotted spot within the crystal and affixes itself to it.

I have gone through Pauling's *gedanken experiment* once again for a purpose: it shows us the rhetoric of the self-assembly metaphor at work. The self-assembly metaphor draws on the deliberate erasure of the statistical mechanics phase. The ingenuity of the chemists who engineer molecules seemingly capable of self-assembly is predicated upon a combination of time and chance. The seemingly teleological is made possible only by the haphazard.

And the oxymoron embodied in the expression 'self-assembly' is thus both explained and deconstructed.

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To sum up: Theodore L. Brown's book is excellent. Yes, it is very much incomplete. But the very fact that it begs for such extrapolations as I have just outlined is a testimony to its excellence. Brown did not wrap it up into a fully formed and definitive opus. That he provided a mere introduction to such an important topic shows not only his authorial modesty, but also how conscious he was of the magnitude of the task ahead.

Metaphor is central to science, indeed. And we chemists, at least those of us interested in the philosophy of the discipline, ought to follow suit; and we need to start a careful and systematic examination of the metaphors chemistry thrives upon.

Pierre Laszlo:
April-October: "Cloud's Rest", Prades, F-12320 Sénergues, France;
October-April: "L'Orée du bois", POB 665, Pinehurst NC 28370, USA;
pierre@pierrelaszlo.net